

REPRODUCTION AND EGG INCUBATION IN THE WESTERN BEARDED DRAGON, *POGONA MINOR*

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INTRODUCTION

The bearded dragons (*Pogona*: Storr 1982) are a distinctive genus consisting of eight species (Greer 1989) of medium to large agamid lizards named for the familiar beard, which is used in threat displays by the larger species (from the Greek "pogon" for beard). The Western Bearded Dragon, *Pogona minor minor* (Sternfeld 1919) is a medium-sized member of the genus and is found over much of southern and central Western Australia and the adjacent western deserts of South Australia and the Northern Territory (Storr 1982). In the smaller species, such as *P. minor*, the beard is greatly reduced and is not readily visible during open-mouthed threat displays (pers. obs. DP). Although the distribution of *P. minor* covers almost one third of mainland Australia, some aspects of this species' life history and reproductive biology are not well documented. Our reproductive observations here are based on the incubation of eggs obtained from three gravid lizards.

METHODS

One gravid lizard was collected in

November 1996 (32°01'S, 120°44'E: M. Peterson) and a further two in November 1997 (32°47'S, 116°55'E: 32°46'S, 116°55'E: D. Pearson) in south-western Western Australia. They were air-freighted to the University of Sydney, and kept in glass aquaria with a thick layer of soil for substrate. Live crickets and cockroaches were offered as food and were readily eaten. Lizards were given the opportunity to thermoregulate under a 75W reflector globe. As wild-caught gravid agamids often lay their eggs indiscriminately within the cage so that many are destroyed due to dehydration (pers. obs. PH), these lizards were given an interperitoneal injection of 60 iu/kg of synthetic oxytocin to stimulate egg laying. The 1996 lizard was injected 9 days after arrival, and the two 1997 lizards on the second day after arrival in Sydney. Each lizard was weighed before injecting oxytocin and again immediately after parturition, and relative clutch mass was calculated by dividing the weight loss due to clutch mass by the female's post-partum mass. Each lizard was given a single injection and laid the entire clutch within 1 to 2 hours.

Eggs were weighed within an hour of laying and then individually buried 3/4 deep (i.e. the upper 1/4 of the egg surface remained visible) in numbered 125 ml glass jars three-quarters filled with vermiculite to which 120% water by weight had been added. The jars were covered with clear sandwich wrap (Glad-Wrap), sealed with a rubber band, and jars containing eggs from each clutch were divided between either a 25 or a 29 °C refrigerated incubator. Temperatures in these incubators were regularly checked against a calibrated thermometer and were usually within ± 0.2 °C of the designated temperature. Jars were moved between shelves within each incubator twice each week, and were not opened until the hatchlings were seen. Incubators were checked daily and the date of hatching was recorded when the egg was 'pipped' (when the hatchling first slit the shell). When each lizard had fully emerged from the egg, usually some hours after pipping, it was removed from the jar and brushed to remove vermiculite, then weighed and measured (snout-vent length (SVL) and total length). Both

the adult females and hatchlings had yellow tongues and mouth lining. Sex was determined by hemipene eversion (Harlow 1996), then hatchlings were euthanased and preserved. The adults and hatchlings are deposited in the reptile collection of the Western Australian Museum.

RESULTS

Table 1 gives reproductive data for the three adult females, including relative clutch mass. Table 2 gives the mean clutch data for their eggs and hatchlings. When hatchling data are grouped and analysed by incubation temperature, hatchlings from each incubator are not significantly different in SVL ($F_{1,19} = 3.29$, $P = 0.09$), however there is a highly significant effect of incubation temperature on tail length ($F_{1,19} = 50.0$, $P < 0.0001$). Those lizards from the 29 °C incubator had tails with a mean length 8.4 mm (17%) longer than their 25 °C incubated siblings.

The twelve eggs incubated at 25 °C

Table 1. Reproductive data for three female *Pogona minor*. Lengths are in mm, mass in grams.

Female number	Snouth-Vent Length	Total length	Gravid mass	Post-partum mass	Relative clutch mass	Clutch size	Date of oviposition
1	130	350	68.21	49.76	0.371	9	23-Nov-96
2	109	295	43.51	29.11	0.495	8	12-Nov-97
3	103	274	36.88	25.87	0.426	7	24-Nov-97

Table 2. Egg and hatchling data for the three clutches of *Pogona minor* incubated at 25 and 29 °C.

Clutch number	Mean egg mass (SD, n)	Mean hatchling mass (SD, n)	Mean hatchling snout-vent length (SD, n)	Mean hatchling total length (SD, n)
1	2.06 (0.07, 9)	1.92 (0.08, 8)	37.8 (1.0, 8)	89.4 (3.3, 8)
2	1.99 (0.06, 8)	1.91 (0.13, 8)	39.1 (0.8, 8)	95.6 (5.0, 8)
3	2.01 (0.06, 7)	2.00 (0.05, 6)	38.0 (0.3, 6)	93.8 (3.5, 6)

hatched after a mean of 105.2 days (standard deviation = 3.1, range 100–109 days) and resulted in 9 females and 3 males. At 29 °C the incubation period was considerably shorter with a mean of 60.4 days (SD = 2.3, range 58–64 days), and produced five female and five male hatchlings. One egg failed to develop at each temperature; these were laid by females 1 and 3. The sex ratio at 25 °C is not significantly different from 50/50 ($\chi^2 = 3$, $df = 1$, $P = 0.08$), nor is there any significant difference in the sex ratio of hatchlings from the two incubation temperatures used here ($\chi^2 = 1.47$, $df = 1$, $P = 0.26$).

DISCUSSION

The only published data on egg incubation in this species is based on the incubation of four clutches from lizards caught at Lort River, WA (Bush 1992). Our data are in general agreement with Bush (1992), although he recorded shorter incubation periods at similar temperatures to us. For example, at 25 °C his incubation period was 28 days (27%) less than ours, and his 28 °C incubation was nine days shorter than our 29 °C incubation period. As the incubation period of reptile eggs generally decreases with increasing temperature (Packard and Packard 1988), these differences may reflect a geographical difference in developmental rates within the distribution of this species. However, this seems unlikely given that our lizards and Bush's were all caught within about 400 km of each other.

Both the clutch sizes we recorded and those of Bush (1992) agree well with the much larger data set of Pianka (1986) for this species. He recorded a mean of 7.6 eggs for this species in Western Australia, but provides no data

on female size. Bradshaw (1981) reported a similar mean clutch size (8.2 eggs) for this species, listed the range of clutch sizes as 5–19 eggs, noting that it is a multiple clutching species laying at least 2 clutches per season.

Our observation of an incubation temperature effect on tail length in hatchlings is similar to other laboratory incubation studies on both agamids (e.g. Harlow and Shine 1999) and skinks (e.g. Elphick and Shine 1998). In the Montane Skink *Bassiana duperrayi*, tail length differences among hatchlings from different incubation regimes last only up to about six weeks after hatching (Elphick and Shine 1998), after which time 'short tailed' lizards from cold incubation temperatures have attained similar tail lengths to their warmer incubated siblings.

Greer (1989) showed that, based on 7 reports from the literature, there was no correlation between female body size and clutch size in this species. We have added both our data and Bush's (1992) to this same data set and find this lack of correlation remains true ($r^2=0.003$, $P=0.83$, $n=16$). Clutch size for the lizards used in this analysis did not increase with body size and varied from five to nine eggs, while female SVL varied from 96 to 130 mm (Chapman and Dell 1977, 1978, 1980a, b; Dell and Chapman 1978, 1981; Smith 1976).

In this geographically widespread species, northern populations are reported to oviposit from August to September (Saint Giron, Bradshaw and Bradshaw 1992), to which we add the observation of a gravid female seen digging a nesting burrow at Millstream-Chichester National Park, WA, on 17 July 1999 (21°35'S, 117°06'E: pers. obs. DP). Populations south of latitude 30°S are reported to breed from October to December (Bradshaw 1981). All four

records of lizards collected with oviducal eggs from north of 30°S were in September (Dell and Chapman 1979, 1981; Smith 1976), while those from south of 30°S that laid eggs or contained oviducal eggs when collected were in September (1), October (4), November (8) or December (1) (Browne-Cooper 1985; Bush 1992; Chapman and Dell 1977, 1978, 1980a, b; Dell and Chapman 1978). These data are indicative of the highly seasonal nature of reproduction in this species, and support Bradshaw's (1981) conclusion that this difference in reproductive timing with latitude is due to climatic differences.

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